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The Horizon of the South Valley Hill Rocks in Pennsylvania. By Dr. Persifor Frazer.

(Read before the American Philosophical Society, December 15, 1882.)

The regions of the State in which the above rocks occur having been independently studied by different observers, their labors have been brought to contact, and it is found that a difference of theory almost as old as geological investigation in this country, exists in the respective views of the workers.

The substance of one of these theories has just been issued in the Report C₆, of the Second Geological Survey Reports, of which the subject is, "Philadelphia County and the southern parts of Montgomery and Bucks, by Mr. Charles E. Hall." *

The first argument advanced to prove the formation of the schists of the South Valley Hill subsequently to the Chester limestone is, that all the dips of the latter are southward or under the former. That this is so in the majority of cases (though with dips differing both in direction and intensity), is undoubtedly true, but there are exceptions to this rule in Sadsbury, Caln, East Caln, West Whiteland, East Whiteland and Tredyfrin; in other words, in six out of the seven townships in which this contact occurs in Chester county. [See table on page 108 of Memoir on the Geology of S. E. Pennsylvania, by writer.]

These exceptions to the general rule are just of such a character as one would expect if a fault had traversed a region of high but generally reversed dips. †

* In the introduction to this volume, Prof. Lesley mentions the Serpentine of Bryn Mawr as turning south towards the town of Chester, and not continuing in its south-west course through Delaware and Chester counties. The evidence of this did not appear from a somewhat rapid search through Mr. Hall's volume. On page 88 he gives the course of the Serpentine as far west as to a point a little south of Bryn Mawr, and on pp. 25 and 26 he speaks of the outcrops as belonging to one deposit, and clearly indicates his belief that they are of synclinal structure though apparently scattered.

It is difficult to believe that the Serpentine at Bryn Mawr is not connected with that north of Radnor, &c., and does not belong to the belt which traversing Chester county with a breadth between the extreme lines of isolated outcrops of from five to eight miles, becomes very largely developed in West Nottingham and the neighboring townships of Chester and Lancaster.

† It is of course a slip of the pen when Prof. Lesley says that the presence of Hudson River plant-forms is shown in Prof. Frazer's Report C₂. C₂ is devoted to Adams and part of Franklin counties, &c. Nor is any such statement in C₃.

There was in the collection of specimens at the Lincoln University a fossil said to have been found in one of the Peach Bottom slate quarries which was determined to be *Bulhotrephis flexuosa*. All efforts, however, to find this fossil in place were unsuccessful. Besides this, even if the Peach Bottom slates were determined to be of Hudson River age, it would be very far from proving that the great mass of the South Valley Hill schists was of this age. Pains were taken in the description of the Susquehanna Section, pp. 140-141, to show that the structure below Fishing creek, and especially near Peter's creek, was not by

The writer takes issue with Mr. Hall, as will appear further on in his statement, as to the absence of large masses of schist in contact with the Potsdam and with the Laurentian north of the Chester valley.*

Mr. Hall's argument is virtually as follows :

(1.) "*The Philadelphia, Manayunk and Chestnut Hill beds or the South Valley Hill, which is equivalent to part of them, cannot be lower than the Laurentian (Third Belt of Rogers).*"

This will be universally conceded.

(2.) "*It is clear that the Potsdam sandstone was deposited on this Third Belt.*"

This is not clear except, perhaps over a limited area. It is not true of the Potsdam in Lancaster, nor is it true of the Potsdam in Southern Chester, nor in parts of Northern Chester. For instance, the evidence that the Potsdam, between Doe Run and Toughkenamon, underlies the limestone and overlies the chlorite schists of that region is very strong. If the limestone interposed between the quartzite and the schists, then a border of limestone should show on the east and west ends along the irregular boundary of the Potsdam area, but it does not.

A series of small detached exposures of limestone stretch east by north from the Doe Run limestone and like the latter show no trace of Potsdam on their northern edges. These as well as the Doe Run limestone, are held to be older than the Potsdam, because the dip is S. or S. E. continuously from the South Valley Hill southwards, *decreasing* in intensity in that direction, so that if not monoclinal the structure must be considered *anticlinal*, and *cannot be synclinal*. The meaning of this is that the Doe Run limestone is younger than the crest of the Valley Hill, and that its southern edge is younger than its northern edge (since the preponderance

any means as clear as in the region north-west. It would be perfectly easy, as there pointed out, to place the Peach Bottom slates *above the quartzite* without deranging the structure of the upper region, as therein suggested. The objection to placing the series above the limestone, *i.e.*, that no limestone appeared between the gentle axis of Tocquan creek and the slates, of course would not be an objection to those who credit the Tocquan schists themselves with being above the limestone.

Two explanations of Hudson River slates at Peach Bottom are possible without changing the horizons of the measures to the N. W. One is the omission here altogether of the limestone in the series. The other (held by Prof. Barrois, who visited the region), a fault line north of the slate belt.

It is only fair to admit, however, that the Hudson River age of these quarries is not proven.

* The discovery of Mr. Lewis as to the two kinds of scratches made by the ice and the creep, must be regarded as an important application of the reasoning of the Scotch geologists to our own country. In some cases Mr. Peach and Mr. Horne have been able to distinctly ascribe three distinct lines of markings to movements of very different age.

The colors on the geological maps are somewhat confusing. The dark red, which in the scale is called the intermediate Manayunk belt, seems to be applied on the map to the northerly Chestnut Hill group, and *vice versa*.

of southerly dips continues across the belt). On its southern edge rests the Potsdam in W. Marlboro' township, still with a south dip (*i.e.*, S. 10° E.- 45° ; S. 5° E.- 70° ; S. 20° W.- 40° ; E. 20° S.- 40° , &c., &c.), that rapidly becomes gently undulating and almost horizontal: and this structure continues to the Delaware line.

The axes of the Chikis anticlinal folds can be seen to be mica schist of similar character to that of the South Valley Hill.

The rock underlying the possible Potsdam quartzites in the lower Susquehanna, are clearly of the same character and series.

The Potsdam in York county is seen to overlies the same schists near Wrightsville and York, near the former of which, as if to settle all doubt, two or three folds bring to the surface within a short distance all the measures above and below it. The Potsdam of Franklin county which lies upon the South mountain covers these same schists, and the very numerous varieties of clays and associated iron ores which are due to their decomposition.

The North Valley Hill quartzite in Sadsbury, Valley, East and West Brandywine, Upper and Lower Uwchlan, and other townships, is preceded and succeeded by gneissoid and chloritic mica schists, as seen at Atglen, Pomeroy, * Stottsville, Sadsburyville, north of Downingtown, on the Brandywine, north and south of Lionville, and at other places.

In this connection, the following, taken from the notes which were made by Mr. Hall and the writer, when, in September, 1876, they visited together Harper's Ferry, and made a section of the Potomac river in its vicinity, may not be without interest. It is necessary to premise that Mr. Hall holds the opinion, which is the natural deduction from his views of the horizon of the South Valley Hill schists, that the rock which the writer has designated "Mountain Creek Rock" from its occurrence in the part of the South mountain which is contiguous to this stream, is a representative of the Potsdam.

The exposure at the head of the bridge on the Maryland side, opposite Harper's Ferry, is of a great mass of this schistose rock with fragments of pink quartz, dipping S. 30° E.- 45° . This continues for an horizontal distance of 1461 feet (445 meters) east and west of the bridge, along the Potomac river.

To the west there appears an hydro-mica schist, dipping S. 40° E.- 18° , but curling so as to render it difficult to ascertain the true dip.

Further west are met in succession:

- | | | |
|---|---|--|
| A | { | Greenish chlorite slates. |
| | | Hydro-mica slates very much convoluted. |
| | | Hydro-mica slates. |
| | | Chlorite slates dipping E. 20° S.- 35° . |

All the above have practically one dip.

* Stottsville, which is omitted from the geological map of Chester county, is on the southern side of the valley opposite Pomeroy.

- Very compact dark blue slate S. 30° E., -26° .
 Same, with N. W. dip for a short distance.
 Same. Dip E. 30° S. -26° .
 Same. Dip N. 30° W. -24° (in ravine 300 ft. wide).
 Same. Dip E. 15° S. $\pm 30^{\circ}$.
 B { Same. Much intersecting quartz.
 Same. Dip \pm S. E. $\pm 40^{\circ}$.
 Same. Dip \pm S. 35° E. -25° .
 Sandy slate, weathered nacreous schist E. 30° S. -20° .
 Iron ore clays.
 Limestone, with traces of fossils.

The horizontal distance covered by group A is 4341 feet, and by group B, 6060 feet.

It will not be easy to construct an inversion with these dips. It cannot be denied that *this* Mountain Creek rock lies on chlorite and hydro-micas, and, if there be no fault, according to Mr. Hall's theory, the fossiliferous limestone should lie about 3000 feet below these schists.

At 1029 feet east of the bridge the Mountain Creek rock, still dipping E. 25° S. -25° , is replaced by hydro-mica schist *as it were* by the gradual dying out of the fragments of quartz. The dip in the first part of these measures, which assumes the entirely changed form, is E. 30° S. -32° . This goes on alternating with quartzite and chlorite schists for 2700 feet, when a Mountain Creek rock comes in lying unconformably against the preceding. A repetition of the Mountain Creek rock commences from here, which is about 100 feet west of the first house* [*in 1876] of the settlement on the Maryland side of the river, opposite Harper's Ferry.

Chlorites, hydro-micas and quartzites therefore clearly lie above and in contact with the Potsdam if this be its representative.

(3.) "*But it is equally clear that the mica schists and gneisses are not found between the Primal and the rocks of the third belt.*"

This is, perhaps, equally clear with Proposition 2, but no more so.

As incidentally mentioned above, the whole structure of the east flank of the South mountain is opposed to this view. Here the schists lie on the central kernel or axis which, whether it be Laurentian or Huronian is, without doubt, older than the rocks we are discussing.

In Section 9, of Report CC, small synclinals of Potsdam are seen resting on the schists. In Section 7 of CC, four miles S. E. of Mt. Holly, the Potsdam (?) quartzite is seen overlying and underlying the chlorite slates.

At Chikis a belt of schists underlies the upper Potsdam quartzite and overlies the lower quartzite.

If the quartz rock of Peter's creek be the Potsdam, it lies on chlorite schists. So do the detached masses of Potsdam quartzite of North Codorus, Spring Garden, and Manheim townships in York.

The same is true of the Potsdam between Doe run and Toughkenamon, and in other places in South Chester and in Sadsbury, E. and W. Brandy-

wine (north of Downington), and Upper and Lower Uwchlan, north of the Valley.

As the premise is not admitted, neither can be the conclusion, which is, that :

(4.) "*If the mica schists were older than the Potsdam sandstone, they must have been deposited up to a geographical line which is sharply defined.*"

It does not seem that this follows ; but the suggestion about the geographical line opens the door at once to another explanation of which the grounds will be more fully stated presently.

This hypothesis is : That a fault line runs along the South Valley Hill, bringing up the lower pre-Potsdam schists and Laurentides. That this fault does not continue to the extreme eastern point of the synclinal, but leaves it near the eastern extremity, and pursues a course a little to the south of the latter, thus cutting off the southern extension of the Potsdam, but necessarily leaving a part of the northern sheet which, laid down unconformably on Laurentian and Huronian, has been subsequently eroded from the former except along the Bound Brook Branch R. R. This hypothesis is offered, with all modesty and reserve, simply from an inspection of Mr. Hall's map, and without personal study of the ground. But at least it seems possible that that which has happened to the limestone beds, when the fault passed through them, might happen to the enclosing Potsdam when its direction was through the latter.

(5.) "*Even supposing a fault which in all probability does exist along their northern edge, there would still be some remnants of these rocks to be found in their normal position upon the syenites of the Third Belt, and fragments of the rapidly disintegrating schists would have been entombed in the Potsdam sandstone itself, even supposing them to have been swept off the underlying rocks north of the present limit.*"

It seems evident that the conditions are very different here from those which obtain in Chester and further west. The Susquehanna River section illustrates at Tocquan creek just the state of things spoken of here.

The axis of this great anticlinal where, without any doubt whatever, the lowest rocks on this river, within the limits of the State, are exposed, consists of a gneiss nucleus on which lie chloritic and hydro-mica, and finally (where Potsdam might be expected) quartz schists or schistose-quartz slates.

Mr. Hall's own definition of his "Edge Hill rock," too, would seem to render it unnecessary to cite examples elsewhere. He defines this rock, the type of his Potsdam, to be "*usually a fine-grained white or gray sandstone and quartzite, with scales of light-colored mica. It is usually thinly laminated. Occasional beds of fine conglomerate are met with.*" (p. 45.)

What better example of the entombed remains of the underlying schists could be expected ? If the beds are thinly laminated, it is evident that the materials out of which they are composed were greatly broken up, and nothing would remain of the schists under the circumstances but the mi-

caceous minerals composing them, Mr. Hall does not state the nature of the fragments forming the conglomerate, but on page 46 the significant statement is made that, "*Itacolumite and hydro-mica schist* have been applied to the specimens analyzed."

There can be no error as to the rocks thus spoken of, as appears from six field numbers which are given of specimens of Potsdam analyzed, of which the first two are found on referring to the analyses to be "*Itacolumite*" and the last four "*Hydro-mica schist*." It will hence be unnecessary to multiply examples of the same kind which might be taken from any of the four counties enumerated above. The fact is indisputably established by Mr. Hall himself that remains of the schists are abundantly found in the Potsdam.

At this point the simple statement is made that the same difficulties are encountered in trying to find a place for the schists until the upper limit of the limestone is passed. As it is well known that there is an abundance of slates above this limit, the inference is drawn that the schists belong there.

This part of the discussion may be left with the remark that to the knowledge of the writer no extensive series of *chloritic* schists has been found to belong to the measures which are without dispute above the limestone of II.

A brief resumé of the principal reasons for assigning to these schists a lower horizon may be here roughly sketched :

(1.) There can be no doubt that the straight and narrow valley called the Chester Valley is connected actually with the great Lancaster limestone, and that it represents a part of a synclinal fold. The anticlinal once connecting it with the larger mass of limestone passed over (and probably high over) all of northern Chester county. If the schists to the south of the valley lie on the limestone, then the entire thickness of the latter must plunge beneath the surface within the limits of the valley. At places (as between Atglen and Pomeroy), the actual space which may be filled by limestone varies from a few hundred to fifteen hundred feet. But the limestone as measured on the Neffsville and Wrightsville sections is about 2700 feet thick. Of course if there be an upthrow on the south, any amount of the upper part of the limestone may have been eroded and any small portion of the lower beds left.

The dips are northward along the western part of Sadsbury township ; and they are in sandy mica schist and gneiss on the north side [as for example N. 10° W.-30° (Atglen) ; N. 45° W.-10° ; N.-50° (near Parkesburg) ; N. 45° W.-40° (ditto)]. The limestone when first found in place by the machine shops in Parkesburg strikes E. 25° N.-vertical. Further east near Pomeroy it is on the northern edge of the valley N. 10° W.-50°. Decomposed gneiss just north of Pomeroy gives a succession of S. E. dips about S. 10° E.-85°. A few hundred feet south of the north dip in the limestone is a dip \pm S.-80°, and a thousand feet or so in the same direction S. 15° E.-60° etc.

North of the gneissoid schists again the quartzite dips about S. 15° E- 45° , and therefore underlies these schists while the limestone either abuts upon them or overlies them in a sharp upward curve, which can no longer be traced.

(2.) The objection to the mathematical straightness of the line of junction of such soft rocks as the hydro-mica schists and the limestones is a serious one. Nothing is more likely, on the other hand, than that such a mathematical line of demarcation should be established by a line of fracture.

(3) The absence of limestone from the junction of the Potsdam and the schists from Huntingdon Valley eastward on Mr. Hall's map, is difficult to explain if these schists really belong above the limestone, and there be no fault along this line. If on the other hand there be a fault (which naturally extends along the South Valley Hill), it is singular that it does not bring up the underlying limestone and broaden that valley if the schists of the South Valley Hill are superior to the limestone.

(4.) The limestone of Adams, York and Lancaster counties believed to be No. II of Rogers is much mixed with schistose and micaceous matter in its inferior layers and is usually surrounded by schists from which this foreign matter is derived.

The limestone of Chester county, near Stottsville, Pomeroy, Parkesburg, and for the whole length of the Chester Valley, is similarly mixed with micaceous matter and frequently resembles a mica schist more than a limestone.

(5.) The Potsdam quartzite and sandstone near Coatesville are similarly mixed with micaceous material, and this texture may be very frequently observed in the lower layers of the Potsdam elsewhere in Chester as well as where Mr. Hall has observed it.

(6.) The contact of the limestone sometimes with the Potsdam and sometimes, when the latter is absent, with the schists, may be observed in lower Lancaster and apparently on the southern side of the great (Tocquan?) anticlinal which passes through Sadsbury townships of Chester and Lancaster counties.

(7.) In various places in East and West Brandywine and Lower Uwchlan, chlorite and hydro-mica schists are abundant below the Potsdam. The series is well exposed from a short distance north of the E. Caln border on the North Branch of the Brandywine past Dowlin's Forge and Dorlan's Mills.

(8.) If the schists south of the Chester Valley be younger than the limestone, and the Doe Run and Chester Valley limestones represent but one horizon, there must be a synclinal fold between the two.

But it has been stated above that the dips are flatter towards the south, so that if there be here a plication, it is an anticlinal.

(9.) There should be evidence of Potsdam south of the belt of limestones striking with that of Doe Run to the east, but there is not.

(10.) There should be evidence that the Doe Run limestone is above the Potsdam to the south, but the former appears to dip under the latter.

This limestone as well as the small detached bodies just alluded to seem to be analogous to that between Scottsville and Rockville in Bucks county.


(11.) There are small tongues and isolated patches of Laurentian rocks occurring in the midst of these southern schists. One comes into Chester county from the east in Eastown and Treddyfrin townships, and another occupies a small area near West Chester. These patches are bordered on all their sides by these schists with no intervening rocks. The bordering rocks therefore cannot belong to a group above the Potsdam and the lower Silurian limestone.

(12.) Several localities in Kennett Square and New Garden townships exhibit areas of Potsdam rocks surrounded by these schists with no intervening limestone. The schists therefore cannot belong to an horizon superior to the latter.


These are some of the reasons which are opposed to the structure suggested by Mr. Hall.

The section on Mr. Hall's p. 32 is so different from the same section which the writer made in 1880, and the conclusions which Mr. Hall draws from his section, are so important, that a rough copy of the writer's section is herewith subjoined, on an approximate scale of 1425 feet = 1 inch. The direction of the section is about that of the average dip or S. 12° E. It is necessary to explain that the first group of dips is projected on the line of section at Henderson's Station from the road west of that point, and the Primal must lie west of where this section begins.

If this junction be accepted, however, from Mr. Hall's observations, it will not affect the important conclusions which suggest themselves. First, of a possible fault between the limestone with part of its underlying schists and the mica-schists to the S. E. ; and secondly the synclinal character of the limestone near Conshohocken, with an anticlinal of the underlying schists to the south-east cut by a trap dyke.

N. 120° W. 

Scale about 1425 ft. to 1 inch.

 S. 120° E.

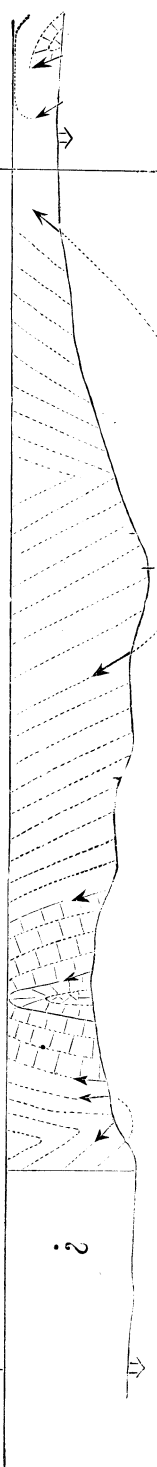
Mechanicsville.

Henderson's
Station.
Fault (?)

Mica Schist, Hydro-mica schist and Gneiss.

Limestone.

Gneiss.
Trap.



Marble S. 10° E.-67°.

Mica Schist S. 20° E.-62°.

Clay and Mica Schist fragm.
Fault (?)

Mica Schist N. 28° W.-50°.

Mica Schist and hydro-mica schist
Summit of Ridge.

Mica Schist S. 10° E.-50°.

Mica Schist and rotten gneiss frgs.
Mica Schist and gneiss frgs.

Limestone S. 20° E.-85°.

Limestone S. 15° E.-80°.

Limestone S. 15° E.-85°.

Gneiss } S. 15° E.-85°.
 } S. 25° E.-45°.

Trap Conshohocken.